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Dr. Robert A. Iacovazzi, Jr., Editor

FY-2D VISSR visible band degradation determined using the Dunhuang monitored calibration site

The FY-2D geostationary meteorological satellite was launched on 8 December 2006 and stationed above the equator at 86.5^{o} East. The main instrument is the Visible Infrared Spin Scan Radiometer (VISSR), with one visible band and four infrared (IR) bands. Every summer since launch calibration experiments are carried out in Dunhuang to determine the absolute calibration coefficients for VISSR's visible band. During the experiments, ground reflectance, aerosol optical depth, sounding, and standard meteorological parameters were measured and plugged into the 6S model (Vermote and co-authors, http://6s.ltdri.org/) for the purpose of calculating the apparent reflectance.

While the output digital count (DC) is not linearly related to the response voltage, the response voltage is linearly related to the input radiant energy. A lookup analog to digital (AD) relation table is used to find out the response voltage corresponding to the output DC. The calibration coefficient is calculated from the ratio of the response voltage and apparent reflectance using Formula 1.

$$S_c = cos(\theta_s)\frac{r_0^2}{r^2}\frac{\rho(\theta_s,\theta_v,\varphi_s-\varphi_v)}{V_{N_c}-V_0} \qquad \textbf{(1)}$$

Here, S_c is the slope, $\rho(\theta_s,\theta_v,\varphi_s-\varphi_v)$ is the apparent reflectance, and V_{Nc} and V_0 are respectively the voltages corresponding to the output DC=N_c and DC=0. The important factor in the solar band site calibration is the site BRDF. Two methods have been used to estimate this parameter: BRDF model with corrections, and direct BRDF measurement through the satellite's viewing angle. By using the instrument shown in Figure 1, the ground BRF could be measured to calculate the AMBRALS BRDF model.

Figure 1. Instruments used to determine the BRDF.

Since the BRDF will be a bit different for a change of location and time, the vertical reflectance was measured at several sample positions in order to calculate correction *A* defined by Formula 2 and applied in Formula 3.

$$A = \frac{1}{11}\sum_{i=1}^{11}\frac{\rho\perp(\theta_s,0,0)}{\rho_{model}(\theta_s,0,0)} \qquad \textbf{(2)}$$

$$\rho(\theta_s,\theta_v,\varphi_s-\varphi_v) = A\cdot\rho_{model}(\theta_s,\theta_v,\varphi_s-\varphi_v) \qquad \textbf{(3)}$$

A portable instrument was used to measure the directional reflectance just through the satellites' viewing angle, as shown in Figure 2. The observing zenith and azimuth could be controlled by the compass and protractor assembled on the measurement pole.

Figure 2. Portable instruments measuring the directional reflectance.

The comparison of the two methods is shown in Figure 3. The relative error of the model compared to the direct measurements is below 2.5%, either for zero or large view zenith angle (VZA) (approximately 46^{o}).

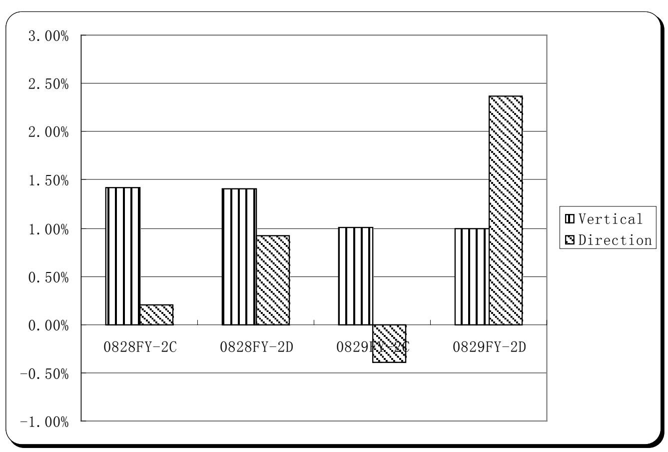

Figure 3. Mean relative differences between measurement and model for the FY-2C and FY-2D VISSR visible channel on 28 and 29 August 2009.

The field's BRDF may temporarily change after a sand storm or precipitation. At that time the second method is more accurate. Both methods are validated using MODIS L1b products. The apparent reflectance is compared to MODIS

L1b data and only reflectances with 6% or less difference to MODIS L1b data have been used to calculate the calibration slope.

Figure 4 is the calibration slope of the visible detectors – 1A, 2A, 3A and 4A – of VISSR on FY-2D given in the order of scan lines in the nominal projection HDF file. Meanwhile, the mean slope of each year is shown in Table 1.

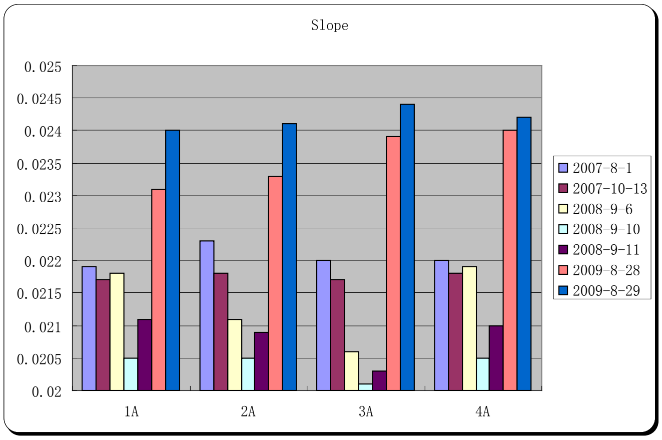

Figure 4. FY-2D VISSR's visible band calibration slope.

Table 1. Annual Mean Slope.

Date	2007	2008	2009	Relative Degradation 2007-2008	Relative Degradation 2007-2009
1A	0.0218	0.0211	0.0236	-3.11%	7.72%
2A	0.0221	0.0208	0.0237	-5.67%	7.21%
3A	0.0219	0.0203	0.0242	-7.19%	10.00%
4A	0.0219	0.0211	0.0241	-3.56%	9.57%
Mean	0.0219	0.0209	0.0239	-4.87%	8.63%
RSTD	0.49%	1.81%	1.24%		

It was found that the response did not degrade during the first year after launch, on the contrary it improved. Root cause of this phenomenon is not known at this time. After 2 years in orbit, detectors have degraded approximately 9%. The statistic of relative STD showed that the difference between detectors is significant enough to lead to image striping.

[by Drs. Y. Li, Y. Zhang, Z. Rong, X. Hu, J. Liu, L. Zhang, and L. Sun (NSMC/CMA)]

GSICS detects stray light contamination in GOES infrared images

Stray light is radiation from outside of an instrument's field of view (FOV) that nonetheless enters the instrument aperture and contaminates measurements of radiation from the FOV. The GOES Imager and Sounder are particularly vulnerable to stray light contamination around midnight during equinox season, when the Sun can be close to satellite's line-of-sight (LOS) (see Figure 1). In the past, a Keep Out Zone (KOZ) was

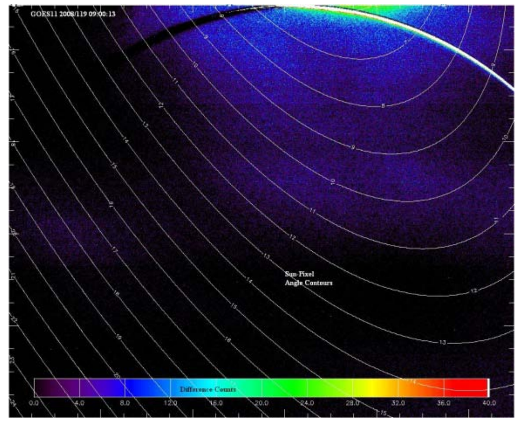

Figure 1. GOES11 Imager North Hemisphere visible channel image affected with stray light on 28 April 2008 immediately after midnight. Contours show sun to pixel angles, which increase radially from about 7° near the top-center of the figure to about 24° at its bottom-left corner.

established in GOES operation to ensure instruments health and safety and to conserve power during eclipse. It has also largely shielded images from stray light contamination. For recently launched GOES-13/14/15, and for the future GOES-R series satellites, instruments are capable of being subjected to direct sunlight and operating through solar eclipse. Therefore, stray light contamination is becoming of greater concern with this new capability.

Recent investigations revealed that stray light impact is greater than previously recognized, and Figures 2 and 3 show that GSICS can detect stray light contamination. Figure 2a shows a positive bias of the GOES-11 Imager within a few hours of

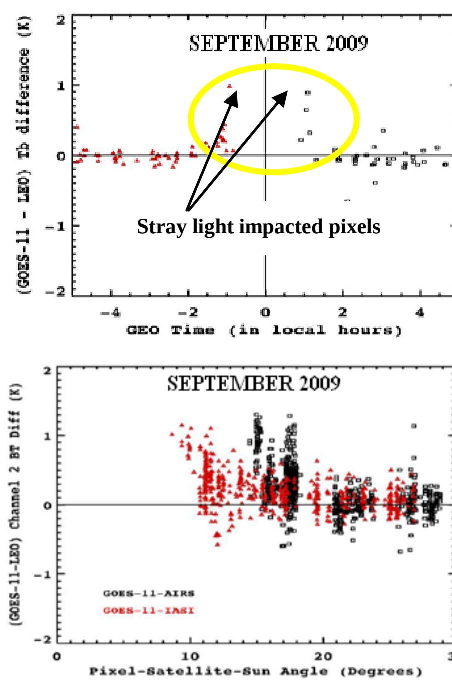

Figure 2. Brightness temperature differences for the 3.9 μm channel between GOES-11 and two hyperspectral instruments in low earth orbit (with red color for collocations with IASI and black color for those with AIRS), plotted as a function of satellite local time (panel 2a), and corresponding separation angle between the lines of sight from GOES-11 to the Sun and to the pixel (panel 2b), during equinox season.

midnight during equinox season, when the collocated pixel LOS is as small as ~10° from the Sun LOS (Figure 2b). Such bias is absent during solstice season (Figure 3a) when the Sun is more than 18º away from collocated pixels LOS, which suggests that stray light contamination caused GOES-11 Imager bias during the equinox season. GSICS is valuable to guiding the development of the stray light correction algorithm and aiding the validation of images corrected for stray light.

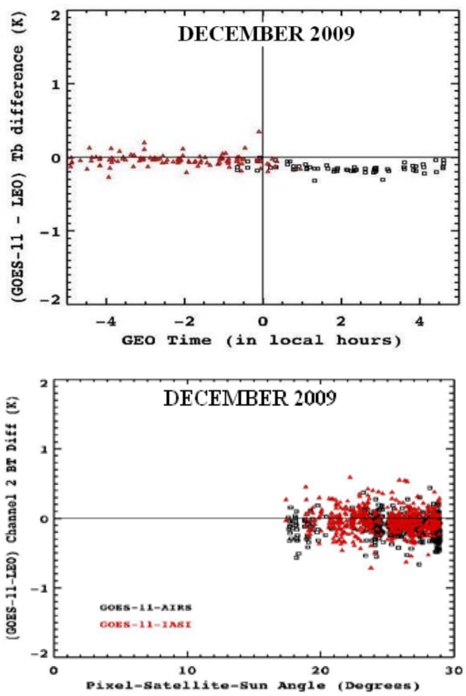

Figure 3. Brightness temperature differences for the 3.9 μm channel between GOES-11 and two hyperspectral instruments in low earth orbit (with red color for collocations with IASI and black color for those with AIRS), plotted as a function of satellite local time (panel 3a), and corresponding separation angle between the lines of sight from GOES-11 to the Sun and to the pixel (panel 3b), during solstice season.

[By Drs. X. Wu, M. Rama Varma Raja and G. Sindic-Rancic (NOAA)]

News in this Quarter

Summary of the Joint GRWG-V and GDWG-IV Meeting

The annual meetings of GSICS Research and Data Working Groups (GRWG and GDWG) were held from 9 to 11 February 2010 at CNES in Toulouse, France. Attendees represented CNES, CMA, EUMETSAT, LMD, NASA, NOAA, JMA, KMA, RAL and WMO, and some of them braved extreme winter weather to be there. Other participants from JMA and NOAA joined the meeting by teleconference – although, ironically, this was problematic due to power cuts caused by the blizzard in Washington D.C.

Philippe Goudy introduced impressive CNES facilities, parts of which were later covered by an interesting tour. This was followed by progress briefings by the working group chairs and the GSICS Coordination Center deputy, and then by a report from Jerome Lafeuille (WMO) on QA4EO (Quality Assurance for Earth Observations). It was agreed that conformance of GSICS products to QA4EO guidelines shall be achieved as part of the GSICS Product Acceptance Procedure (GPPA).

The following joint session focused on moving GSICS products towards operational status and developing procedures to document them appropriately as they progress from *demonstration* through *pre-operational* to full *operational* status. Products currently approaching demonstration status include the *GSICS Correction* for IR channels of various geostationary imagers as well as the *GSICS Bias Monitoring* of these, which are now recognised as distinct, but related products.

The second day and first part of the third day comprised break-out sessions of the two working groups. The theme of migration to operational status continued in more detailed discussions of the Data Working Group. A revised structure of the GSICS Data and Products servers was agreed to reflect the new distribution path, and formats and file naming conventions refined. The GPPA was also reviewed and requirements for document management and helpdesk functionality discussed. These are all essential steps to ensure GSICS can efficiently generate consistent products, with traceable quality statements.

GRWG first heard presentations from Dave Smith (Rutherford Appleton Laboratory, UK) on the Along Track Scanning Radiometer (ATSR) and Andy Heidinger (NOAA) on the Advanced Very High Resolution Radiometer (AVHRR). Both guests had been invited to describe the inter-calibration of these instruments, following feedback from the first GSICS Users' Workshop. Both presentations provided valuable experience learnt from the comparison of these with other instruments both in infrared and solar channels.

The remainder of the GRWG session focussed on developing a strategy for the inter-calibration of solar channels. It was agreed that initial efforts would be concentrated on the geostationary imagers, aiming to develop *GSICS Correction* and *GSICS Bias Monitoring* of their solar channels relative to a reference instrument, such as MODIS (Moderate Resolution Imaging Spectroradiometer). It was recognised that a range of different inter-calibration methods are available, based on comparing views of invariant targets or direct comparison of collocated, ray-matched observations. Each method offers different advantages and disadvantages and covers different ranges of operating conditions. These were summarised in a series of presentations by different attendees. A strategy was agreed upon that principal investigators will lead a full review and error analysis of each method. This is necessary to combine methods in the development of GSICS products for solar channels.

Tim Hewison provided a summary of feedback and lessons learnt from the first external beta tester of EUMETSATs prototype GSICS Correction. This led to a discussion on how users can be notified of any updates and suggested topics for the second GSICS Users' Workshop, which will be held during the EUMETSAT Meteorological Satellite Conference in Cordoba, Spain on 21 September 2010.

The agenda and minutes of the meeting can be accessed by following the "Meeting reports" link at the GSICS website: http://gsics.wmo.int. Due to time constraints, some agenda items were postponed to a series of web meetings, which will continue the dialogue within GSICS.

The participants (see photo below) were particularly appreciative of CNES for the professional organisation of the meeting, their generous hospitality in Toulouse and their support in arranging logistics – including last minute train booking following flight cancellations due to bad weather. The working groups are hoping that their next meeting, scheduled to be held in Seoul, South Korea in early March of 2011, will be accompanied by more forgiving weather.

Photograph of Joint GRWG-V-GDWG-IV Workshop courtesy of CNES)

(by T.J. Hewison [EUMETSAT])

Microwaves Meet GSICS

In March 2010 the Washington D.C. area hosted three meetings specialising in satellite microwave radiometers and their use for climate studies:

1. MicroRad 2010 is a quasi biannual conference, which typically oscillates between Italy and the USA. It has long been a waterhole of the global passive microwave community to share new research results, instrument designs, innovative techniques and technologies.

2. The GPM X-cal Working Group compares the calibrations of similar, though not identical, microwave radiometers of the Global Precipitation Mission constellation to assure consistency. This group's activities are already well-developed for inter-calibration of TRMM Microwave Imager, TMI, with WindSat. They plan to extend this analysis to include Advance Microwave Sounding Radiometer -EOS (AMSR-E), then Special Sensor Microwave Imager (SSM/I), while starting to look at sounders. This group has been facing issues common to GSICS – e.g. whether to issue re-calibrations or corrections – but has not concentrated on operational products yet. They are also interested in NWP Double-differencing methods.

3. Workshop on Climate Data Records from Satellite Microwave Radiometers was hosted at the NOAA Science Center. The workshop covered topics on instrument calibration and climate data record (CDR) development from long-term satellite microwave observations taken by NOAA, NASA, Navy/Air Force, and EUMESAT operational polar-orbiting satellite series sensors, including Microwave Sounding Unit (MSU), Advanced MSU (AMSU), Stratospheric Sounding Unit (SSU), SSM/I, and SSM/I Sounder (SSM/IS). The main purpose of the workshop was for the NOAA CDR development teams to respond to and get input from users and other CDR developers on all key concepts and concerns to ensure NOAA CDRs are both highly useful and appropriately up-to-date. The workshop also provided a mechanism for running a NOAA transparency program to gain community acceptance and credibility by formally and openly describing the CDR approaches.

GSICS was represented at each of these meetings, with Fuzhong Weng and Tim Hewison giving presentations. They reported the results of NOAA's inter-calibration activities MSU/AMSU/SSU using Simultaneous Nadir Overpasses and outlined strategic plans to develop GSICS products for microwave instruments. The initial plan for GSICS is to review existing activities and methods, as well as to consider users' requirements in a gap analysis. GSICS also needs to consider suitable reference instruments, which ideally should be in non-synchronous orbits, with calibration traceable to SI standards. Strategic plans for combining different microwave sensor inter-comparison methods were reviewed at a web meeting scheduled 9 June 2010.

(by T.J. Hewison [EUMETSAT] and F. Weng [NOAA])

Just Around the Bend …

GSICS-Related Meetings

- **GPM X-Cal Meeting**, 29-30 June 2010, Univ. of Central Florida, Orlando, FL, USA
- **CALCON**, 23-26 August 2010 (GSICS Spotlight Session to be held during one day), Utah State University, Logan, Utah, USA.
- **Second GSICS User's Workshop,** To be held as a breakout session during the 2010 EUMETSAT Meteorological Satellite Conference 20-24 September 2010, Córdoba, Spain.

GSICS Publications

Please send bibliographic references of your recent GSICS-related publications to Bob.Iacovazzi@noaa.gov.

GSICS Classifieds

Submitting Classified Advertisements: Are you looking to establish a GSICS-related collaboration, or do you have GSICS-related internships, exchange programs, and/or available data and services to offer? *GSICS Quarterly* includes a classified advertisements section on an as-needed basis to enhance communication amongst GSICS members and partners. If you wish to place a classified advertisement in the newsletter, **please send a two to four sentence advertisement that includes your contact information to Bob.Iacovazzi@noaa.gov.**

With Help from our Friends:

The *GSICS Quarterly* Editor would like to thank those individuals who contributed articles and information to this newsletter. The Editor would also like to thank *GSICS Quarterly* Associate Editor, Gordana Sindic-Rancic of GCC, European Correspondent, Dr. Tim Hewison of EUMETSAT, and Asian Correspondent, Dr. Yuan Li of CMA, in helping to secure and edit articles for publication.

Submitting Articles to GSICS Quarterly: The *GSICS Quarterly* Press Crew is looking for short articles (<1 page), especially related to cal/val capabilities and how they have been used to positively impact weather and climate products. Unsolicited articles are accepted anytime, and will be published in the next available newsletter issue after approval/editing. **Please send articles to Bob.Iacovazzi@noaa.gov, *GSICS Quarterly* Editor.**